

**NUCLEAR SPECTROSCOPIC
INVESTIGATIONS BY MEANS OF ENERGY
SELECTING ELECTRONIC DEVICES**

BY

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Almqvist & Wiksells Boktryckeri AB

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Inaugural dissertation

BY

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Nuclear spectroscopic investigations by means of energy selecting electronic devices

In several nuclear investigations it is desirable to collect as much information as possible about the disintegration of weak radioactive samples. The author has been interested in experiments of this type. In most cases the spectroscopic measurements have been performed by means of pulse-height analysis.

The expression »pulse-height spectroscopy» has been used to characterise certain types of nuclear measurements in which the energy of a particle or quantum absorbed in a radiation detector is determined by measuring the amplitude of the voltage pulse delivered by the detector. All types of detectors that have a linear relation between the energy absorbed and the height of the output pulse can be used. Pulse-height spectroscopic measurements have proved to be a valuable complement in many nuclear investigations. This is especially the case when only weak samples are available because of low yields in the production processes and in coincidence measurements where the ratio between true and chance coincidences is improved by using weak samples, measured under large solid angles.

A summary is given of the following articles which all describe nuclear experiments involving pulse height spectroscopy. The detectors and electronic instruments used in these experiments are also described.

- I. B. Åström: Some electronic instruments used in nuclear spectroscopic investigations. *Arkiv f. fys.* 12, 215 (1957).
- II. B. Åström: Scintillation spectrometer with constant relative channel width. *Nucl. Instr.* 1 (1957).
- III. B. Åström, A. H. Wapstra, S. Thulin, and I. Bergström: Calibration of a scintillation spectrometer for the comparison of γ - and X-ray intensities. *Arkiv f. fys.* 7, 247 (1953).
- IV. I. Bergström, S. Thulin, A. H. Wapstra, and B. Åström: K -conversion coefficients of γ -transitions occurring in the decay of Kr^{85m} , Xe^{129m} , Xe^{131m} , Xe^{133} , and Xe^{133m} . *Arkiv f. fys.* 7, 255 (1953).
- V. B. Åström, B. Johansson and I. Bergström: The 148-keV electric quadrupole transition in Tl^{200} . *Arkiv f. fys.* 12, 205 (1957).
- VI. B. Åström: Half-lives of isomeric states in Pb^{202} , Pb^{203} , Pb^{206} , and Tl^{202} . *Arkiv f. fys.* 12, 237 (1957).
- VII. H. Atterling, W. Forsling, L. W. Holm, L. Melander, and B. Åström: Element 100 produced by means of cyclotron-accelerated oxygen ions. *Phys. Rev.* 95, 585 (1954).

In (I) is given a technical description of $\text{NaI}(\text{Tl})$ scintillation detectors for electromagnetic radiations and an ionisation chamber for α -rays. Descriptions and circuits of the following electronic devices are also given: Linear amplifier, stabi-

lized high tension supply, scalers, electronic timer, and preamplifier for ionisation chamber. The operation and performance of an automatic scintillation spectrometer and an α -ray spectrometer with a 50-channel pulse-height analyzer and drift compensation, is also described.

A single channel pulse-height discriminator with properties convenient for automatic recording of spectra is described in (II).

In (III) the efficiency of a NaI(Tl) scintillation spectrometer for detecting photons of different energies is determined by absorption methods, and by measuring isotopes with simple decay schemes and known internal conversion coefficients.

The K -conversion coefficients of γ -rays in the decays of Kr^{85m} , Xe^{129m} , Xe^{131m} , Xe^{133} , and Xe^{133m} have been measured in (IV) by a combination of β -spectrometer and scintillation methods.

In (V) the properties of the 148-keV transition in Tl^{200} have been studied. This work included the determination of the half-life ($8 \pm 2 \mu\text{sec}$) of the first excited state in Tl^{200} by means of delayed coincidence measurements. The coincidence arrangement which utilized NaI(Tl) crystals, is described.

The work reported in (VI) involves the determination of the half-lives of Pb^{202m} (3.62 ± 0.03 hours) and Pb^{203m} (6.09 ± 0.10 sec). The decay of these metastable states was followed and recorded for more than ten half-lives. In the measurement of the half-lives of Pb^{206m} ($128 \pm 5 \mu\text{sec}$) and Tl^{202m} ($600 \pm 200 \mu\text{sec}$), standard laboratory instruments including an oscilloscope were combined in an arrangement that made it possible to measure delayed coincidences in the microsecond range.

In (VII) is described the production and identification of an isotope of element 100. When that experiment was done, the only instrument available for the determination of α -energies was a 16-channel pulse-height analyzer and an ionisation chamber without a grid. The measurements therefore gave a less accurate determination of the α -energy. However, the experiment has been repeated¹ and the result showed that the mass number assignment was correct.

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Björn Åström

¹ S. Amiel, A. Chetham-Strode, Jr., G. R. Choppin, A. Ghiorso, B. G. Harvey, L. W. Holm, and S. G. Thompson. U. C. Radiation Laboratory Unclassified Report UCRL-3610, December 1956. In this paper the α -energy of Fm^{250} is given as 7.43 MeV.

